

GYMNOSPERMOUS WOOD FROM THE KIMMERIDGIAN OF EAST SUTHERLAND AND FROM THE SANDRINGHAM SANDS OF NORFOLK

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ABSTRACT. A description is given of the types of gymnospermous wood occurring in material collected from the Kimmeridgian of the East Sutherland coast. These types are compared with those collected from the Sandringham Sands of Norfolk. All of the material is described in terms of *biorecords* and *events*: references are made to previously described species in the form of *comparison records*. In traditional taxonomy some of the specimens are referable to *Cedroxylon* Kraus and the remainder to *Pityoxylon* Kraus. A close similarity is found between the two collections of wood providing a useful rough correlation of the base of the Sandringham Sands with the Kimmeridgian.

THE present work is based on two collections of gymnospermous wood; one from the Kimmeridgian of the East Sutherland coast and the other from the base of the Lower Portlandian of Norfolk (Sandringham Sands). The Scottish material consists of large calcareous petrifications from the shore at Helmsdale. The material from Norfolk is calcified in a highly ferruginous matrix and was obtained during the excavation of a drainage channel near West Dereham. The differing natures of the materials led to the use of two distinct techniques. Cellulose peels were made from the Helmsdale material but rock sections were prepared in studying the Sandringham Sands specimens as they required excessive etching time in attempts at making peels.

STRATIGRAPHY

The Sutherland material was collected mainly from the shore near Helmsdale where it is abundant; specimens occur with decreasing frequency northwards and southwards from Helmsdale along most of the outcrop of the Kimmeridgian from Kintradwell to Dun Glas. These wood specimens are most frequently encountered where there are outcrops of the boulder beds (Pl. 129, fig. 1). These remarkable beds consist of 'immense angular blocks and smaller waterworn stones of Middle Old Red Sandstone rocks embedded in a matrix of gritty, shelly limestone' (Plemister 1960). This matrix yields plant megafossil compression remains, a fauna of a littoral marine type with typical Kimmeridgian fossils and also some ammonites. Bailey and Weir (1933) considered that the breccias or boulder beds collected at the base of a submarine fault-scarp, the littoral shells and plant debris being swept down from the upthrow side together with Old Red Sandstone material by tsunamis or tidal waves energized by earthquakes along the fault.

It is only in comparatively recent years that the exact age of the Sandringham Sands of Norfolk has been worked out. Various excavations in the county have been of great assistance in providing exposures with ample fossil material. Larwood (1961) mentions the site where the Norfolk material described in this paper was found. Excavations

(TL 655997) immediately south-west of Abbey and West Dereham Station, about two miles to the east-north-east of Fordham, exposed part of the Sandringham Sands. The section exposed was about 6.5 m deep. The lower beds consisted of a conglomerate passing down into very pebbly dark grey sands; these rested on 1.5 m of blue-grey silty sands which formed the bottom of the section. Contractors' bore-logs for this locality show that the blue-grey silty sands, with occasional beds of harder cemented sandstone, continue below the visible base of the excavated section for at least 8 m, giving a thickness of about 16 m for the sands at this point. The blue-grey silty sands contained a layer of nodules; in the latter were large fragments of wood and phosphatized casts and moulds of many bivalves, some belemnites and occasional ammonites. Of the fossils Casey (1961) said that this part of the excavation revealed a suite indicative of a Berriasian (Infra-Valanginian) fauna new to Britain. He described the occurrence of the fossils in nodular masses of hard grey-brown glauconitic sandstone with carbonized plant debris about 10 m above the base of the formation. Included were species of *Hartwellia*, *Isocyprina* and *Isodonta* which have their closest parallels in the Upper Jurassic.

Further evidence for the age of the Sandringham Sands was provided by a section exposed by an excavation for a North Sea Gas pipeline near King's Lynn (TF 65 15). Casey and Gallois (1968) describe a previously unrecorded sequence of ammonite faunas in a facies of glauconitic sand and phosphate nodules. The genus *Subcraspedites* was succeeded by forms of the group of *Garniericeras tolijense* (Nikitin), diagnostic of the Uppermost Volgian of the Northern U.S.S.R., in turn succeeded by similar ammonites accompanied by an undescribed genus ancestral to the basal Cretaceous (Ryazanian) *Hectoroceras*; the sequence continued with *Hectoroceras* and *Surites*. In addition, Ager (1971) has strengthened the correlation of the Sandringham Sands with the Volgian of the U.S.S.R. in studies on the brachiopod genus *Rouillieria*.

The present work therefore lends considerable support to an Upper Jurassic age for the base of the Sandringham Sands, by showing that there is a very high degree of correlation between the gymnospermous woods of these beds and those of the Kimmeridgian of East Sutherland. The possibility has to be faced that in both the Sandringham Sands and in the Helmsdale Kimmeridgian the wood material might have been re-worked. However, in the case of the Norfolk material one piece of wood (MGC/T) shows borings by xylophagous crustacea (or mollusca) which are fresh and do not appear to have suffered the abrasion likely to have occurred in re-working. The largest pieces of wood seen at the Helmsdale locality measured 40 cm by 25 cm (Pl. 129, fig. 3). Associated with

EXPLANATION OF PLATE 129

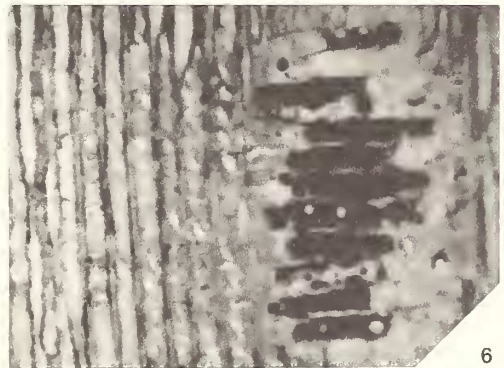
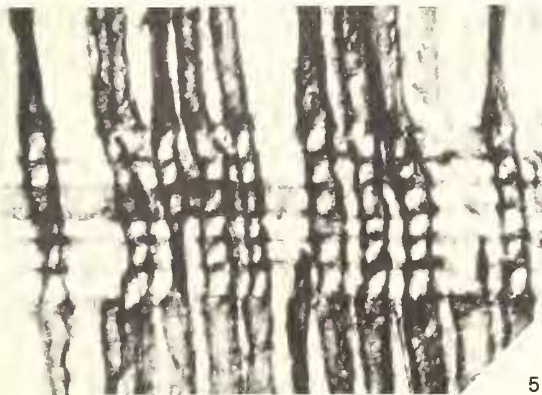
Fig. 1. About eight square metres of the boulder beds on the shore at Helmsdale, polished by the sea and showing numerous clasts.

Figs. 2, 6. Biorecord I TRACHEIDOXYL MS. 2, Specimen MGC/T, a portion of a tangential longitudinal section with transverse sections of a number of rays, some of which are partially biseriate; $\times 150$.
6, Specimen MGC/A, cross-field pits in a radial longitudinal section, the ray cells are filled with resin; $\times 150$.

Fig. 3. Two large pieces of calcified wood, drilled by Recent rock-boring molluscs, on the storm beach at Helmsdale; length of hammer 30 cm.

Fig. 4. cfA 2 TRACHEIDOXYL RC. Specimen B 34/17, part of a tangential longitudinal section showing a fusiform ray with resin canal; $\times 150$.

Fig. 5. cfA 1 TRACHEIDOXYL MS. Specimen B 34/9, large cross-field pits seen in a radial longitudinal section passing along a ray; $\times 150$.



CREBER, Late Jurassic petrified wood

the fossil corals referred to above is a large quantity of carbonized wood fragments up to 3 cm in diameter; connection between this wood and the petrified wood has not yet been demonstrated.

SYSTEMATIC SECTION

For description of the material use is made of the biorecord system of Hughes and Moody-Stuart (1969). A biorecord is defined as a conceptual taxon based on a specimen from a stated locality. The biorecord is not in essence different from a palaeontologic species at the stage of description by its originator, but differs in the use that can subsequently be made of it; virtually no literature search is involved and description priorities are not considered. The title heading and reference line for a biorecord (e.g. 1 TRACHEIDOXYL *MS*) consists of (a) a serial number which outside this paper would be preceded by an identifier such as author's initials, (b) an informal (but stored) classification guide, and (c) an author's working reference printed in italics to indicate that it is a 'non-search' item. The term TRACHEIDOXYL is used to indicate that the specimen involved is a detached portion of wood characteristically composed of tracheids with only a minor proportion of other tissues.

Additional specimens are listed as comparison records; those which cannot readily be distinguished from the biorecord are designated 'cfA'. Specimens of progressively lower grades of comparability then receive the prefix 'cfB' if there is one quantitative difference and 'cfC' in the case of further divergence.

BIORECORDS JUR 28 27 GB XYL

The above heading, in a form suitable for data storage, indicates that the biorecords are wood specimens from localities in the British Jurassic. The Ages/Stages are those used in the Fossil Record (Harland *et al.* 1967), numbered consecutively back from Recent. Thus 28 and 27 are the Oxfordian and Kimmeridgian, respectively. All specimens are lodged at the Sedgwick Museum, Cambridge.

1 TRACHEIDOXYL *MS*

Diagnosis. Growth rings well marked, 0.5 cm broad. Early wood tracheids cross-section $50\ \mu\text{m} \times 50\ \mu\text{m}$, reducing only slightly through the season which terminates with a few rows of very small elements. Bordered pits, $15\ \mu\text{m}$ diameter, on the radial walls of the tracheids, uniseriate arrangement, sometimes contiguous and compressed. Rays uniseriate or partially biseriate, 2 to 20 cells in height, average 11 (Pl. 129, fig. 2). Cross-field with a solitary, large, oblique pit.

Record Specimens. MGC/A, MGC/B, MGC/Q and MGC/T from the Flood Relief Channel cut in the Sandringham Sands to the south and east of Abbey and West Dereham Station (TL/655997).

Description. This biorecord is readily distinguished by its highly characteristic cross-field pitting (Pl. 129, figs. 5 and 6), the 'eiporen' of the German authors.

Comparison Records. cfA 1 TRACHEIDOXYL *MS*: (1) *Metacedroxylon scoticum* described by Holden (1915) from the Kimmeridgian of Loth, East Sutherland; Sedgwick Museum Specimen No. K613. (2) Specimens B34/9 and B34/20 from Helmsdale, East Sutherland.

2 TRACHEIDOXYL RC

Diagnosis. Growth rings very variable in breadth, 1–3 mm. Early wood tracheid cross-section $40\ \mu\text{m} \times 40\ \mu\text{m}$. Marked zone of late wood, 12 rows of smaller dense elements. Bordered pits on tracheid radial walls 10–12 μm in diameter, bars of Sanio. Pits generally uniseriate but smaller and biseriate at ends of tracheids. Vertical (Pl. 130, fig. 1) and horizontal resin canals. Rays uniseriate or fusiform with resin canal, 2–20 cells in height, average 8. Cross-field with one to two small bordered pits.

Record Specimen. MGC/R from the Sandringham Sands (TL/655997).

Description. This biorecord is of considerable interest in that it possesses rays with fusiform cross-sections (Pl. 129, fig. 4) and bars of Sanio (Pl. 130, fig. 2) on the radial walls of the tracheids. It would appear that there is no other undoubted record of such a wood as early as the Kimmeridgian.

Comparison Records. cfA 2 TRACHEIDOXYL RC: Specimen B34/17 from Helmsdale, East Sutherland and 3 TRACHEIDOXYL RD (Specimen MGC/O) from the Sandringham Sands (TL/655997). cfB 2 TRACHEIDOXYL RC: *Piceoxylon scleromedullosum*, described by Shimakura (1937) from the Senonian of Sakhalin has many similar features to 2 TRACHEIDOXYL RC; a much closer comparison could be made if the preservation of 2 TRACHEIDOXYL RC would allow the certain determination of the existence of ray tracheids (there is some evidence of their presence but insufficient to include as an item in the diagnosis).

3 TRACHEIDOXYL RD

Diagnosis. Growth rings uniform, 0.5 cm broad. Early wood tracheids cross-section $60\ \mu\text{m}$ (Rad) $\times 50\ \mu\text{m}$ (Tan). Gradual transition to late wood through the ring. Bordered pits on tracheid radial walls 17 μm in diameter. Bars of Sanio. Pits generally uniseriate but occasionally biseriate at ends of tracheids. Vertical (Pl. 130, figs. 3 and 4) and horizontal resin canals. Rays uniseriate or fusiform with resin canal, 2–17 cells in height, average 9 (Pl. 130, fig. 5). Cross-field with one to two small bordered pits.

Record Specimen. MGC/O from the Sandringham Sands (TL/655997).

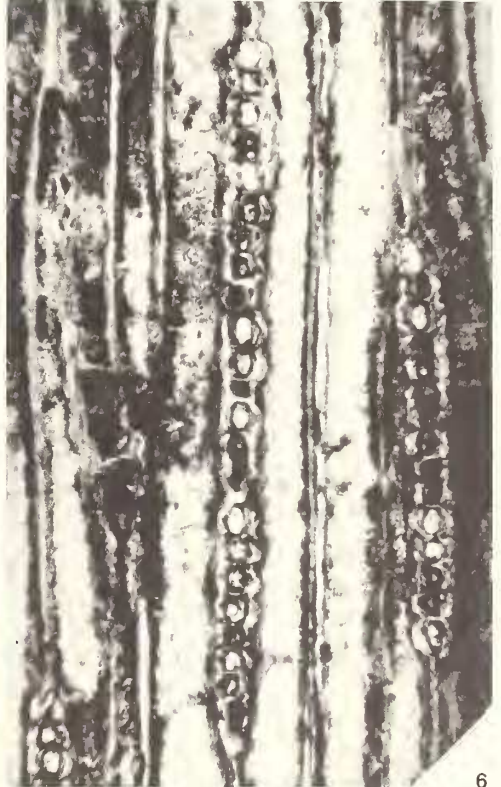
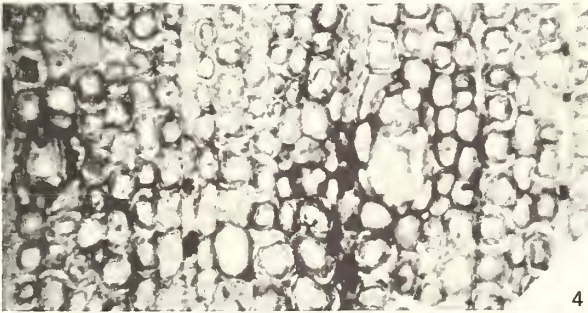
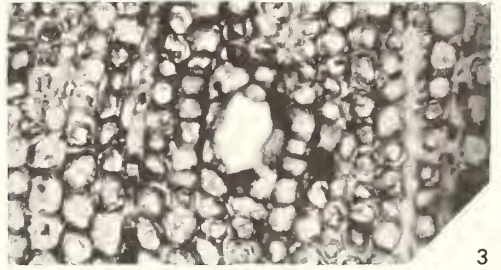
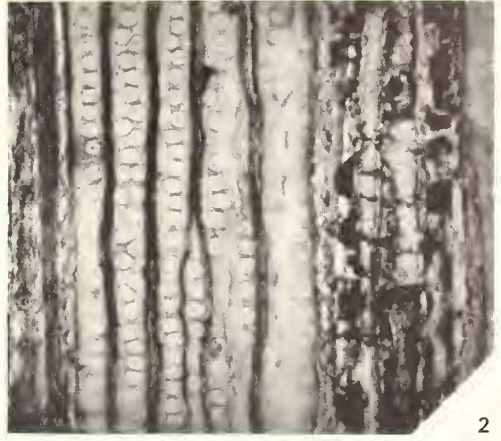
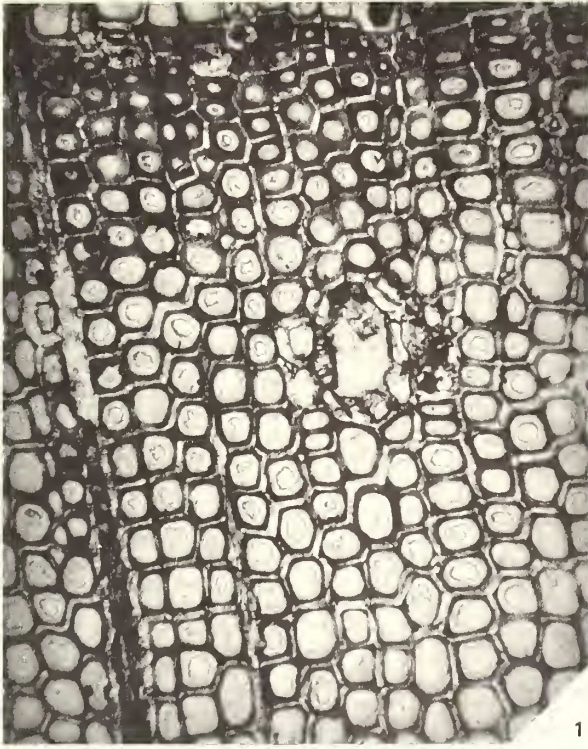
Distinction. This is very similar to biorecord 2 above. In order to avoid conflicting items in the diagnosis they are being maintained separately for the time being. It is fully realized that the differences may only be such as one might expect between pieces of wood from the inner and outer parts of the trunk or between branch and trunk. Collection of further material may elucidate the matter.

EXPLANATION OF PLATE 130

Figs. 1, 2. cfA 2 TRACHEIDOXYL RC. 1, Specimen B 34/17, a vertical resin canal seen in transverse section; $\times 150$. 2, Specimen B 34/17, a portion of a radial longitudinal section showing bordered pits with bars of Sanio; $\times 150$.

Figs. 3–5. Biorecord 3 TRACHEIDOXYL RD. Specimen MGC/O. 3, 4, vertical resin canals seen in transverse section; $\times 150$. 5, part of a tangential longitudinal section showing a fusiform ray with resin canal; $\times 150$.

Fig. 6. cfA TRACHEIDOXYL CH. Specimen K 571, a portion of a tangential longitudinal section showing one of the deep rays; $\times 150$.



CREBER, Late Jurassic petrified wood